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Drawing the Boundaries: Mathematical Statistics in 20th-Century America

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Statistics in Europe and in the United States acquired the status of a separate field only in the 20th century. Until then, it had provided a quantitative tool for analyzing data in various sciences. In the early 1930s, the founding of the *Annals of Mathematical Statistics* and of the Institute of Mathematical Statistics served to institutionalize the profession of mathematical statistics in the United States, and helped to distinguish it as a discipline independent from the social sciences which had previously supported it. This paper examines the American mathematical statisticians' attempts to delineate the boundaries of their profession, focusing on their association with the social sciences, on the founding of the *Annals* and of the IMS, and on the profession's continuing advancement during World War II. © 1996 Academic Press, Inc.

Il n'était qu'au 20ème siècle que la statistique est devenue une discipline distincte. Antérieurement, elle a servi d'outil quantitatif pour l'analyse des données dans les sciences diverses. Dans les 1930s, l'établissement des *Annals of Mathematical Statistics* et de l'Institute of Mathematical Statistics a amené l'institutionalisation d'une profession "statistique mathématique" et a servi à distinguer cette profession des sciences sociales. Ici, j'analyse les tentatives des statisticiens mathématiques américains d'établir les frontières de leur discipline en concentrant sur leurs associations avec les sciences sociales, le fondement des *Annals* et de l'IMS, et le progrès de la profession pendant la deuxième guerre mondiale. © 1996 Academic Press, Inc.

Erst im 20. Jahrhundert bekam Statistik in Europa und in den Vereinigten Staaten von Amerika die Stellung einer eigenständigen Wissenschaft. Bis dahin hatte man es als ein quantitatives Hilfsmittel zur Datenanalyse in verschiedenen Wissenschaften verwendet. Die Einführung der *Annals of Mathematical Statistics* und die Gründung des "Institute of Mathematical Statistics" um 1930 verhalf, den Stand der mathematischen Statistik in den Vereinigten Staaten zu institutionalisieren und sich von den Sozialwissenschaften zu unterscheiden, in die es zuvor eingeordnet worden war. Diese Veröffentlichung untersucht den Versuch der mathematischen Statistiker in Amerika ihre Arbeit abzugrenzen, unter besonderer Berücksichtigung ihrer Verbindung zu den Sozialwissenschaften, den *Annals of Mathematical Statistics,* des "Institute of Mathematical Statistics" und der Weiterentwicklung ihrer Arbeit während des zweiten Weltkrieges. © 1996 Academic Press, Inc.

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INTRODUCTION

In December 1935, the following announcement appeared in the pages of the *Annals of Mathematical Statistics:*

> For some time there has been a feeling that the theory of statistics would be advanced in the United States by the formation of an organization of those persons especially interested in the

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> mathematical aspects of the subject. As a consequence, a meeting of interested persons was arranged for September 12, 1935, at Ann Arbor, Michigan. At the meeting, it was decided to form an organization to be known as the Institute of Mathematical Statistics. [47]

The event heralded by this proclamation declared the existence of what was becoming a scientific community, an association of scholars who defined their field of study as distinct from other subjects, and who institutionalized their means of sharing ideas with one another.

The last two decades of the 19th century had already seen the formation of the major academic disciplines in the United States. In fields as disparate as chemistry, economics, and mathematics, practitioners had begun to pursue more specialized studies, had organized national associations and publications, and had established academic departments in major research universities. As the process of specialization continued into the 20th century, subspecialties emerged and professionalized by a process similar to that followed by their parent disciplines. In particular, the case of mathematical statistics highlights the critical role played in this process by the founding of a journal and a national association.[1]

Major disciplines in the humanities and in the natural and social sciences had formed national organizations and begun journals by the turn of the century, each with slightly different needs in mind. Although it initially placed some emphasis on pedagogical problems when it was founded in 1886, the Modern Language Association quickly shifted its focus to promoting scholarship in order to gain legitimacy for its disciplines in the domain of higher education [50; 67]. In the natural sciences, publications such as the *American Journal of Mathematics* and the *American Chemical Journal* and various associations of the particular scientific communities organized to provide forums for discussion and dissemination of their specialized interests.[2] Disciplinary institutions played a crucial role in the social sciences by shifting emphasis away from social action programs and stimulating intellectual progress [25, 25–29].

To a certain extent, the *Annals of Mathematical Statistics,* begun in 1930, and the Institute of Mathematical Statistics served all of those purposes for the emerging mathematical statistics community. They helped establish the independence and importance of the discipline; they provided a much-needed forum for publishing research that was too technical for the existing statistical journal; and they fostered intellectual advancement by setting standards for research. Most importantly, these institutions served to define more clearly the boundaries of this new community. They helped establish the intellectual parameters of the discipline and allowed members to distinguish their interests and needs from those of the broader academic and scientific communities to which they belonged.

This paper will examine the way in which the mathematical statistics community

[1] Roger L. Geiger calls attention to the importance of the formation of professional organizations in the process of academic professionalization in [25]. For a discussion of academic specialization in the 19th century, see [31].

[2] Regarding disciplinary communities in the natural sciences, see [36; 37; 51].

in the United States carved a niche for itself in the scientific world. We will briefly examine the community's origins in the 19th century and then focus on the founding of the *Annals* and the IMS. Finally, a consideration of mathematical statisticians' contributions to the efforts of World War II will provide a glimpse into the continuing evolution of the discipline that followed the formative period.

STATISTICS IN THE EARLY 19TH CENTURY: ISOLATED INTEREST

The mathematical statistics community in the United States had its origins in a group of researchers for whom descriptive statistics served as a tool for the study of society.[3] This group had come together through the 19th century from such varied interests as economics, medicine, and social reform. While many of their efforts remained amorphous until the last decade of the century, the first sign of a receptive climate for organized studies in statistics appeared in 1839 with the formation of the American Statistical Association (ASA). In November, five people led by Lemuel Shattuck,[4] a printer turned social reformer, met in Boston to found the organization. In addition to Shattuck, the group consisted of William Cogswell, a minister; two lawyers, Richard Fletcher and Oliver Peabody; and a physician, John Dix Fisher [79, 230–31]. They organized for the purpose of encouraging private efforts to obtain statistical information [10, 181]. A few months later, the Association had by-laws, a constitution, 54 New England members, and 15 corresponding members, one as far away as Louisville, Kentucky [10, 181]. They published a single volume of *Collections of the American Statistical Association* from 1843 to 1847, but remained a local organization for most of the middle part of the century [66, 583].

During this period, one man's interests seem to have dominated the ASA's activities. Dr. Edward Jarvis had joined the Association in 1844 and became its president in 1852, a position he held for the next 32 years [29, 85]. Jarvis, born in Concord, Massachusetts, in 1803, had attended Harvard College and began practicing medicine in 1830 [17]. One of the most prominent physicians studying mental health in the United States at mid-century, he opened a house for the treatment of the insane in Dorchester, Massachusetts in 1843 [17].

Jarvis's interests reflected the mid-19th-century view that medicine should function to prevent disease ''by specifying those social and environmental conditions that promoted the maintenance of health'' [29, 3]. Physicians often worked for better housing, for universal education, and for the establishment of institutions to help the poor and the insane [29, 6]. Jarvis, in particular, encouraged the preservation of vital statistics through the ASA for the purposes of understanding the circumstances of health and disease [29, 7]. He believed that a complete and accurate census would

[3] For discussions of the development of statistics in Europe in the 19th century, see [55; 65]. Patricia Cline Cohen provides an account of the emerging importance of statistics and numbers in the popular culture of 19th-century America in [10].

[4] For a biographical account of Shattuck's life, see [79].

> enable us to take the first step toward ascertaining the sanitary and morbidic influences of seasons, atmospheric conditions and localities, of employments, social conditions, circumstances, and habits of the people. [It] will open the way to the discovery of the causes of disease, and probably to the means and methods by which they may be modified, ameliorated, and perhaps extinguished. [33, 164 in 29, 107]

Others involved in improving the national census expressed the hope that accurate facts would inform social policy. Speaking to the American Geographical and Statistical Society in 1859, census official Joseph C. G. Kennedy said that the purpose of statistics "is the amelioration of man's condition by the exhibition of facts whereby the administrative powers are guided and controlled by the lights of reason, and the impulses of humanity impelled to throb in the right direction" [35, 3 in 10, 225]. American researchers in the mid-19th century saw statistics as a useful tool for increasing their knowledge of society.

This trend continued in the second half of the century. Contributions to statistics issued from thinkers exploring questions in the social sciences. Occasionally, too, other sorts of scientists provided examples of interest. In particular, Benjamin Peirce, a mathematician and astronomer at Harvard College beginning in 1833, made a contribution to statistical methods with the publication in 1852 of the first significance test for determining when to reject an outlier [52]. Peirce, responsible for establishing at Harvard "the most rigorous course of mathematical studies yet offered in the United States" [51, 18], also played a key role in directing the professionalization of science in mid-19th-century America [9]. Under his leadership, for example, Cambridge became the center for astronomical studies for the United States Coast Survey. Instituted in 1807 under the Jefferson administration, by mid-century this organization had become the largest scientific institution supported by the federal government.[5] Peirce served as its director of longitude determinations from 1852 to 1867 and as the superintendent from 1867 until 1874. During his involvement, clerks of the survey employed the methods of his 1852 paper [64, 246].

Benjamin Peirce's son, Charles Sanders Peirce, shared his father's interest in mathematics. Born in 1839, he attended Harvard College and later worked under his father at the Coast Survey. Although the scope of his research and writings extended beyond mathematics to include philosophical concerns, he published several papers that played a part in the development of statistics.

Some of C. S. Peirce's work for the Coast Survey reflected a social scientist's interest in population data and in social conditions. In 1872 he presented a paper to the Philosophical Society of Washington in which he analyzed the relationship between the geographical distribution of illiteracy and of winter rainfall in the United States [64, 249]. According to an abstract of the paper, "Mr. Peirce suggested as a possible explanation for the resemblance [between the distributions], that the copious winter rains would produce agricultural plenty, which in its turn would favor indolence" [53, 68 in 64, 249].

[5] For the details of government sponsorship of science and of the Coast Survey in particular, see [20].

In ''On the Theory of Errors of Observations'' [54], which he published as part of the Coast Survey's report for 1870, Peirce discussed his experiments involving an 18-year-old's reaction times on a telegraph [64, 249]. Making 500 measurements a day, he tried to determine the distribution of the reaction times for each day over a period of 24 days. His results suggested that human reaction times exhibited a quantifiable regularity.

The work of the Peirces and of other American scientists doing statistical research in the first three quarters of the 19th century, such as Simon Newcomb, Mansfield Merriman, and Erastus Lyman De Forest,[6] reveals a fairly widespread, although unsystematic, interest in using numbers to quantify understanding about society. Isolated research appeared in a variety of journals, and little collaboration occurred among scientists. The final years of the 19th century brought more organized activity among the users of statistics as the American Statistical Association increased its efforts to become a broad-based institution with more national influence.

THE CLOSE OF THE CENTURY: MORE ORGANIZED PURSUITS

In 1883, Francis A. Walker, an economist and president of the Massachussetts Institute of Technology, succeeded Edward Jarvis in the presidency of the ASA [15, 237]. Until this time, the Association had had no more than 75 members at a time, and no more than 10 members attending any given meeting [15, 238]. By 1889, membership had climbed close to 160 [15, 240], and the Association had begun issuing a journal, *Publications of the American Statistical Association.* A survey of the lead articles in the first volume of the journal reveals that statistical studies continued to emphasize the collection of data for the study of social issues.

Amos G. Warner, a professor of economics at the University of Nebraska, published ''Notes on the Statistical Determination of the Causes of Poverty'' a year after receiving his Ph.D. from the Johns Hopkins University [18]. In that work, Warner saw statistics as a tool to aid the sciences in their search for an understanding of poverty. He wrote that ''nearly all the social and some of the natural sciences must be required to furnish conclusions, and statistics, as the bond servant of them all, will have its share of the work'' [71, 102].

In his ''Park Areas and Open Spaces in American and European Cities'' [28], Elgin R. L. Gould amassed quantitative facts about the amount of developed land in the United States. At the time, Gould worked for the United States Department of Labor, but he would later become a lecturer at the Johns Hopkins University and at Columbia College. He was professor of statistics at the University of Chicago from 1895 to 1896, and later the president of the Thirty-fourth Street National Bank [16]. In his article, he concluded that the growth of park areas had not kept pace with population growth, and he urged large cities to make provision for more open spaces.

The articles by Gould and Warner typify the studies published in this and subsequent volumes of the ASA's journal. For the most part, the articles focus on the particular social issue at hand. Any comments about statistical methods are usually

[6] For a discussion of some of this other work, see [64].

limited to criticisms of previous record-keeping and of collection methods that produce incomplete data.[7] Statistics remained a tool for other sciences rather than an independent subject of investigation and research.

We also find this attitude toward statistics reflected in a discussion of statistical education in the pages of *Publications of the American Economic Association* in 1888 and 1889. Here, Davis R. Dewey, chief of the National Department of Labor and secretary of the ASA, and Carroll D. Wright, head of the Massachusetts Bureau of Statistics of Labor and president of the ASA [19], commented on the current state of statistics instruction in the United States. Dewey's remarks echo the sentiment that statistics exists for the service of other sciences. From his point of view, statistics ''is nothing more nor less than an examination of human life in its various forms by the application of statistical measurements. It is statistics applied to human biology, to political economy, sociology, political science, public and private law. In short, it is encyclopedic in its aims'' [14, 362–63].

Wright's article, ''Statistics in Colleges'' [84], indicates that most instruction in statistics took place in the context of the social sciences. Courses in finance or in political science, such as those offered at the Johns Hopkins and at the Massachusetts Institute of Technology, might include a statistical component [84, 12]. Richmond M. Smith of Columbia College's School of Political Science offered a course called ''Statistical Science: Methods and Results'' that focused specifically on methods of statistical research and analysis [84, 13–14]. In Wright's discussion, we find the continued presence of the expectation that statistics would guide public policy and assist in solving social problems. As he wrote, ''[i]f there is an evil, let the statistician search it out; by searching it out and carefully analyzing statistics, he may be able to solve the problem. If there is a condition that is wrong, let the statistician bring his figures to bear upon it'' [84, 27].

The view, held by Wright and others, of statistics as ''the gathering of original data in the most complete and accurate manner; the tabulation of the information gathered by the most approved methods, and the presentation of the results in compact and easily understood tables'' [84, 17] would prevail among statisticians for the next 30 years. In the meantime, membership in the ASA continued to increase, reaching almost 700 by 1916 [15, 240].

Through this time, there is little indication of any tension between those contributing collections of statistics and results of surveys to the ASA's journal and those interested in developing more theoretical and mathematical elements of the field. However, by the middle of the 1920s, questions had arisen about the role of mathematics in statistical instruction, indicating that the community no longer had a consensus of opinion on these issues.

OPINIONS DIVERGE: EMERGING TENSION AMONG STATISTICIANS

In 1926, the ASA's Committee on Educational, Scientific and Professional Standards[8] published the results of a survey conducted of 142 colleges and universities, seeking information about their statistics courses. The committee seems to have

[7] See, for example, [22; 63]. For further discussion of some of the articles in the first volume of *Publications of the American Statistical Association,* see [66].

[8] Hereinafter referred to as Committee on Standards.

formed in 1924 as the result of a special meeting of the ASA held in December, 1923, discussing "What Statisticians Should Know; How and Where Should Their Training Be Given?" [42, 97]. Participants at this meeting discussed the education of statisticians and their relationship to industry.

Louis I. Dublin, a statistician with the Metropolitan Life Insurance Company, highlighted the need for a director of statisticians in a particular business to have detailed knowledge of that business [42, 97]. Donald R. Belcher, an assistant chief statistician with the American Telegraph and Telephone Company [72], called for an emphasis on the physical and mathematical sciences in the collegiate training of statisticians [42, 98]. The chief statistician of the Western Electric Company, Edmond E. Lincoln, recommended the establishment of a certification bureau that would evaluate potential statisticians' knowledge and abilities and thus give employers a means of determining a candidate's suitability [42, 98]. Further comments emphasized the need for general standards as well as the importance of cooperation between industry and the teachers of statistics in colleges and universities.

The Committee on Standards had formed by June, 1924, chaired by James W. Glover [1].[9] The preparation of a list of standard statistics textbooks defined the committee's first task, completed by September [26, 399]. Along with the publication of the list, the Committee announced plans to conduct the survey mentioned above. Its results appeared in the *Journal of the American Statistical Association* in 1926 [27].[10] They revealed that statistics courses taught in such departments as economics, business administration, and education outnumbered those taught in mathematics departments. Consequently, only rarely did any mathematics more advanced than trigonometry serve as a prerequisite to these courses. In fact, only 11 of the 57 courses in elementary statistics offered through mathematics departments required calculus [27, 420].

The same issue of the *Journal* contained a series of articles discussing the appropriate content of statistics courses and the mathematical background necessary for technical training in statistics. Two of the articles, one by Donald Belcher [7] and the other by Willford I. King, an economist with the National Bureau of Economic Research and professor of economics at New York University's School of Commerce [4; 38], stressed the importance of general computational skills and knowledge of the industry in which the statistician worked. The other article, written by mathematicians Henry Lewis Rietz and Arthur R. Crathorne, argued for the inclusion of more advanced mathematics in the training of statisticians [60].

Belcher repeated the call he had made at the 1923 meeting for an emphasis

[9] Glover established and taught courses in financial, statistical, and insurance mathematics at the University of Michigan. See [78]. Other members were Leonard P. Ayres, W. A. Berridge, R. E. Chaddock, Edwin W. Kopf, Edmond E. Lincoln, and Malcolm C. Rorty.

[10] The ASA's publication had acquired this name in 1922. During the period from 1892 to 1922, the name had varied, with *Publications of the American Statistical Association* usually serving as the title of bound volumes, while individual issues appeared as *Quarterly Publications of the American Statistical Association.* See [66, 583].

on scientific training in the education of statistical workers. However, now his expectations for such training lay in the critical thinking skills it would impart rather than in its mathematical and scientific content. He wrote, "[i]t must not be thought that training in mathematics and the physical sciences is desirable only because of the informational content of these subjects. . . . [They] are characterized by the very type of analytical and sequential thinking for which the business statistician has need" [7, 429].

King's comments distinguished between courses in statistical technique, and courses in interpreting statistics, which would simply familiarize students with sources of statistical information and with the necessary background for reading charts and tables. The former courses would serve those expecting to take up statistical work as a profession. They would teach students to "prepare not only working tables and charts but also those suitable for publication . . . [and to] overcome the difficulties involved in computing averages, measures of dispersion, seasonals, trends, and coefficients of various kinds" [38, 433]. King made no mention of statistical theory or of advanced mathematics.

In contrast, Rietz and Crathorne argued strongly for statistics courses which required more mathematics than elementary algebra. According to these mathematicians, the training of a statistical specialist "involves a high degree of facility in reading substantially all the literature of descriptive and mathematical statistics" [60, 439], in particular, knowledge of partial differential equations and of infinite series [60, 439]. Thus, statistical training necessitated a more substantial mathematics background than most courses required. Rietz and Crathorne challenged what they perceived as a common assumption that mathematics instructors teaching statistics "believe and teach that mathematics takes the place of common sense" [60, 437]. Instead, they asserted that "blind faith in mathematics is more likely to come from one who knows little mathematics" [60, 437], and that a statistics teacher with mathematical training would have the ability to "teach the limitations of mathematics as well as its uses" [60, 437].[11]

In this debate in the pages of the *Journal,* we see the first evidence of division between what would become two groups interested in statistics. Rietz and Crathorne, each holding a Ph.D. in mathematics and serving as professors of mathematics, represented those beginning to explore the theoretical aspects of statistics. Belcher and King spoke for researchers using statistics as a tool for work in other fields. Their attitude echoed that of the first contributors to the *Publications of the American Statistical Association,* discussed above. In focusing on social issues rather than on mathematics, those researchers had not treated statistics as an independent discipline, but as a means of gathering and displaying numerical information arising in their studies.

Over the next 10 years, the differences between these factions would become

[11] Several years later Rietz would complain that existing textbooks on statistical methods had not "gone far toward explaining the nature of the underlying theory . . . [and] the place and importance of probability theory in statistical analysis" [61, v].

more pronounced. Each would more clearly articulate its views on the role of mathematics in statistics and on the ability of the existing statistical community to address the needs of the two groups. In his presidential address to the Association in 1929, Edwin B. Wilson acknowledged that some statisticians ''behave as though a great deal of mathematical background were essential to a safe and satisfactory practice of statistics and . . . so many others behave in the directly contrary way as though no mathematics at all were necessary and much were harmful'' [80, 1]. Although trained in mathematics, Wilson had become professor of vital statistics at Harvard's School of Public Health by this time and seemed to fall squarely in the camp represented by King and Belcher [5]. He allied himself with this camp, confessing that ''if choice must be made between familiarity with his subject and familiarity with mathematics, I should unhesitatingly prefer the former'' [80, 4]. Such sentiments contributed to an atmosphere that appeared unreceptive to those approaching statistical research from a theoretical point of view. By 1929, these people, who would come to identify themselves as mathematical statisticians, seemed to reach some sort of critical mass, and the attitude that Wilson represented motivated them to begin creating a place for themselves in the research community.

THE FOUNDING OF THE ANNALS OF MATHEMATICAL STATISTICS

In 1929, Harry C. Carver, professor of mathematics at the University of Michigan, approached the directors of the ASA with a proposal for a new journal that would focus on mathematical statistics. Carver had received his bachelor's degree in mathematics from the University of Michigan in 1915 and had returned in 1916 as an instructor of mathematics [3], primarily hired to develop courses in mathematical statistics for the University's actuarial program [11, 292]. As Cecil C. Craig, who had received his Ph.D. from Michigan two years earlier, remembered it, ''[i]n those days . . . manuscripts with any mathematical content had little chance of being published by the Journal [of the ASA]. I heard Professor Carver say on more than one occasion that there ought to be a place in this country where a paper in mathematical statistics could appear'' [11, 292]. In presenting his idea for a new journal, Carver argued that while the number of people doing research in mathematical statistics had increased, no suitable outlet for their contributions existed. According to Carver, the directors of the ASA acknowledged that ''most of their membership were economists, bankers and census people whose knowledge of mathematics was very limited,''[12] and who would not want to support research of a more mathematical nature.

After his initial meeting with the ASA, Carver assembled articles for a first issue of what he called the *Annals of Mathematical Statistics*. The Association agreed to allow its members a choice between the *Annals* and the *Journal*, committing to pass along to Carver a portion of the annual dues of those selecting his publication.

[12] Harry C. Carver to Jerzy Neyman, in [46, 172]. An analysis of the membership of the ASA published in 1930 confirms this perception, showing that the greatest overlap in membership occurred with the American Economic Association. See [59].

The rest of the financial and editorial responsibility would fall to Carver [46, 172]. Although he maintained those responsibilities, the *Annals* became an official publication of the ASA. However, by 1933, the ASA's support for the journal had become a concern of the Association, and a special committee formed to examine the financial burden caused by the *Annals*. In light of the increased cost of supporting the periodical and of the ASA's diminishing income, the committee recommended ''that unless publication of [the] Annals can be placed upon a proper financial basis, sponsorship by the Association should be withdrawn'' [AASA4]. For the purpose of ''obtain[ing] evidence that [the] Annals [was] considered really essential to the statistical fraternity'' [AASA4], the committee sent two letters in early December, one to subscribers of the *Annals* and the other to nonsubscribing members of the ASA, requesting information about their willingness to support the *Annals* with a subscription at a higher rate.

The letters, signed by the secretary–treasurer, Willford I. King, indicated that the ASA had been funding about half the cost of producing the journal with money not coming from subscribers. Thus, the publication received much of its support, as King put it, from ''members, most of whom are not specialists in mathematics, and hence find the articles in the Annals not particularly adapted to their needs'' [AASA3]. King also commented on Carver's investment of time and money to the *Annals,* asserting that he ''has not only served without pay but has hired his own assistants and also paid many other expenses. Clearly this situation is entirely unfair to Professor Carver and he rightly feels that it must be terminated'' [AASA3]. Exhorting subscribers that ''every tub should stand on its own bottom'' [AASA2], he asked that they reply to his letter with a commitment to pay an increased subscription rate. The response must not have encouraged the directors, for on 10 January, 1934, the Board sent a letter to members of the ASA, informing them ''that the Annals of Mathematical Statistics are no longer published by the Association but have been turned over to the charge of Professor Harry C. Carver'' [AASA5].

Nearly two years later, the ASA had resumed interest in the *Annals* and had begun discussing with Carver the possibility of the Association's assumption of financial responsibility for the periodical. In May, 1935, Carver and the secretary–treasurer of the ASA, Frederick Stephan, proposed that the ASA take over publication of the *Annals* [AASA11; AASA13]. At the time, the directors declined the proposal, fearing that it represented too great a financial risk to the Association [AASA14].

However, by winter, the ASA appeared ready to reconsider the possibility. In a letter to Carver, Stephan indicated that a misunderstanding about the finances of the journal had made the directors unduly concerned, and that current information suggested that the proposal of the previous spring would receive favorable consideration should Carver wish to resubmit it [HP7]. Carver gave both an account and an interpretation of the events of 1933 in his response to this offer. According to him, King had thought that if the ASA no longer published the *Annals,* its subscribers would send their money to the *Journal of the ASA* instead. The expense of distributing more copies of this publication would not consume all of the new

income, so the Association's finances would be strengthened [HP8]. Carver also claimed that in his "distorted accounting" [HP8] of the *Annals'* expenses, King included a salary for its editor and his assistant, although, as Carver stated, "we agreed at the very start that no salaries would ever be paid to officers of the Annals" [HP8]. Finally, those responsible for the *Annals*, including Carver, had heard nothing of King's concerns or plans until they received the form letter sent by King requesting their commitment to pay a higher subscription rate for the publication [HP8].

King's actions, as well as the ASA's refusal to take over the *Annals* seven months earlier, had made Carver reluctant to commit the future of his journal to the ASA. He wrote to Stephan: "Frankly, I believe that we had better drop all thoughts of having the Annals ever become an official publication of the Association" [HP9]. He saw the ASA's unwillingness to take a loss of three hundred dollars on the journal in spite of having received a substantial grant from the Rockefeller Foundation as evidence "that something is wrong somewhere, and [that] our position would become most precarious when the Foundation withdraws its temporary subsidy to the Association" [HP9].

Throughout the negotiations regarding the founding and financing of the *Annals,* the widening gap between the mathematical statisticians and the bulk of the ASA leadership and membership had become more apparent. As Rietz and Crathorne had argued for the inclusion of a more sophisticated mathematical content in statistics training, Carver had sought to provide a forum for the discussion of theoretical aspects of statistics. His success in obtaining articles for publication and subscribers to his journal indicated that his efforts were addressing a need. On the other hand, the ASA's hesitation to support the *Annals* suggests that its leaders, primarily social scientists, did not consider the needs of the mathematical statisticians great enough to justify the assumption of much financial risk. In a continuing effort to further their professional interests, the mathematical statisticians founded the Institute of Mathematical Statistics (IMS), of which the *Annals* became an official publication. The Institute's founding and emerging role in the statistical community further defined the differences between the professional needs and interests of the mathematical statisticians and those of the social scientists.

THE FORMATION OF THE INSTITUTE OF MATHEMATICAL STATISTICS

The initial impetus for the formation of what would become the IMS seems to have come in October, 1934 from Harry Carver. As he had in 1929 with his desire to start a research publication, Carver approached the officers of the ASA with his thoughts on some needs of the mathematical statisticians. He wanted to promote professional development and to establish recognized standards of achievement [AASA6]. Carver envisioned an organization modeled on the Actuarial Society of America, which would define grades of membership based on a series of examinations [AASA6]. Several years before, the ASA had appointed a committee to investigate the possibility of incorporating some such system within the Association. The idea seemed impractical at the time because of the broad range of interests

among the members [AASA6]. Now, however, Carver thought the mathematical statisticians could implement the idea, and he wanted an organization that would "start out with a clean slate, elect its own officers and edit its own publication" [AASA6].

Frederick C. Mills, president of the ASA, responded to Carver's letter, saying that the Board of Directors had informally considered his concerns and wished to encourage "the establishment of standards of competence, which should serve as measures of the technical ability of practicing statisticians" [AASA7]. Mills expressed the directors' desire to see such standardization accomplished within the Association. He indicated that among the members of the ASA, "[t]here was a natural fear . . . that the creation of a separate organization might serve to weaken the American Statistical Association" [AASA7]. He suggested that those interested in furthering Carver's idea arrange to have a discussion at the ASA's December meeting in Chicago.

Such a discussion did occur. The organizers nominated Henry Lewis Rietz as their first president and decided to solicit support from a group of "persons who [were] actively interested in, and ha[d] contributed to, the development of mathematical statistics" [AASA8]. In addition, they agreed that their new association "would be affiliated with the American Statistical Association, to a degree to be determined later" [AASA8].

Twenty-three people received a letter from Paul R. Rider, a mathematician at Washington University in St. Louis, informing them of these developments and inquiring about their interest in joining the potential organization [AASA8].[13] From their responses and from subsequent correspondence among the organizers, we see a dual strand emerging in the motivation for the founding of what would eventually be the Institute of Mathematical Statistics. Some, like Carver, expressed a desire for standardized methods of measuring statisticians' professional achievements. Others saw the new organization existing primarily to promote research in mathematical statistics, particularly through the support of a professional journal.

Efforts to accomplish the former goal appeared in attempts to create two categories of membership in the Institute: Fellow and Member. In July, 1935, a committee appointed to the task submitted a proposal for a constitution and by-laws to Henry Rietz [HP2]. The committee suggested that the Institute employ a system of examinations to establish standards of membership, but left "[t]he exact nature of the examinations . . . to be worked out by [the] first Committee on Examinations and Qualifications for Membership" [HP2].[14] In a letter to A. L. O'Toole, one of the committee members, Rietz confessed to hesitancy about such a system, fearing that both the cost of administering it and the reluctance of potential members to participate would make the plan unworkable [HP3]. O'Toole continued to urge that the Institute use examinations, or a suitable substitute, "to preserve high standards for the Fellowship" [HP4].

[13] For recipients of Rider's letter, see [32, 288].

[14] Compare the institution of categories of membership in other scientific societies, such as the AAAS. See [62, 76–77].

When the Institute officially organized in September, 1935, the Constitution established the categories of Members, Fellows, Honorary Members, and Sustaining Members, with only Fellows having the privilege of voting in the Institute [AASA1]. Burton H. Camp, Harold Hotelling, and Arthur R. Crathorne received appointments to the Committee on Membership and the only original fellowships in the Institute [AASA15].[15] Their task consisted in setting up standards for the different grades of membership.

In the months before the Institute's official founding, while O'Toole and others tried to work out suitable means for classifying members, other organizers emphasized the need for encouragement and funding of research in mathematical statistics. In response to the original letter sent by Paul Rider, Edward L. Dodd of the University of Texas wrote that "[t]he Annals of Mathematical Statistics looks to me like an orphan or a disinherited child" [AASA9]. He urged that the Institute form to give support to this publication. Allen T. Craig, in his reply to Rider, expressed the belief that because the ASA did not "properly support the publication of mathematical papers," the *Annals* needed the backing of a new, more sympathetic organization [AASA9]. Rietz, in correspondence with Frederick Stephan, secretary–treasurer of the ASA, indicated that "[w]hile the organizers of the Institute have some objectives, relating to qualification for statisticians, . . . I think the matter of suitable provision for publication is the primary objective" [AASA12].

This letter formed part of a discussion among the founders of the Institute and some officers of the ASA concerning the possible affiliation of the Institute with the older organization. Questions about this association remained at issue in the months surrounding the official establishment of the IMS. They also provided evidence that social scientists who did not regard mathematical statistics as a distinct discipline dominated the leadership of the ASA. These leaders worried that a new organization would diffuse support for the ASA by siphoning away its members with more mathematical interests. As mentioned above, Frederick Mills responded to Carver's interest in a new society with concern about the possible effects on the Association. He and the other directors wanted to discourage "a movement which [might] tend toward the disintegration of the Association" [AASA7].

Mills and others felt a need to further the common interests of those working in statistics. In response to an invitation to participate in the founding meeting of the IMS, Mills wrote to Rietz of his belief that the creation of a separate organization would impede "the development of statistics and . . . the application of statistical methods in the various social and natural sciences" [HP5].[16] He did not want to "sterilize mathematical statistics by isolating it from the problems arising in field work" [HP5], but hoped to diminish any distinction between various groups in the Association. Frederick Stephan had expressed the same sentiment in a letter to

[15] The correspondence does not make clear precisely why the group selected these men. They each had a Ph.D. in mathematics and had served as professors of mathematics; Camp at Wesleyan University, Hotelling at Stanford, and Crathorne at the University of Illinois. At the time of the founding of the IMS, Hotelling was professor of economics at Columbia University. See [73; 74; 76].

[16] This letter is also quoted in [32].

Walter Shewhart. He felt that by reducing the opportunities for contact between different factions, the mathematical statisticians would perpetuate the indifference of those who ''had not found many important uses for advanced statistical theory in their work'' [AASA10].

Mills, Stephan, and the other directors of the ASA did not identify with the mathematical statisticians' interest in establishing themselves as a separate professional community. In their positions, Stephan as the director for the Bureau of Social Research [77] and Mills as a professor of economics at Columbia University [75], mathematical statistics served as an aid to research. They did not regard it as an independent discipline. Their perceptions predisposed them to work toward keeping the statistical community unified.

Their attitudes had motivated Carver, Rietz, and others to take steps to create a niche for their own interests. These men had come to see their purposes and needs as different from those who simply used statistics as a tool. In the minds of the mathematical statisticians, the differences legitimized their efforts to create a distinct discipline, one having the same professional status as the social sciences with which they had previously associated yet not existing only to serve those sciences. Some felt that this status could be maintained through affiliation with the ASA if the older organization made efforts to address their needs. Others, such as Shewhart and Carver, wanted to put mathematical statistics on an equal footing with the larger body.

Carver was particularly reluctant to subsume mathematical statistics as a subfield of the broader discipline represented by the ASA. As we saw above, King's actions against the *Annals* had made Carver wary of the Association's offer for support. He complained about the ASA's track record in a letter to L. L. Thurstone of the psychology department of the University of Chicago, writing that ''the American Statistical Association in the past has failed utterly to discharge its duties as the custodian of statistics in this country'' [HP6]. He saw its interest in mathematical statistics as volatile, certain to evaporate in the atmosphere of disinterest towards mathematics created by the general membership of the ASA. Writing to Stephan, Carver maintained that ''the Association—with its present membership—will never represent effectively more than a small fragment of statistical endeavor'' [HP9].

Ultimately, Carver's reluctance proved decisive. His unwillingness to turn over the *Annals* directly to the ASA effectively scuttled efforts to affiliate the IMS with the Association.[17] Stephan acknowledged as much to Rietz in December, 1935, shortly after the above-mentioned letter from Carver. As he saw it, ''any affiliate relationship which we might establish between the Institute of Mathematical Statistics and the American Statistical Association will not involve the Annals of Mathematical Statistics. . . . [the members of the IMS] will probably wish to maintain the

[17] Carver later indicated to Rietz that he would entertain the thought of first turning over the *Annals* to the IMS so that the two organizations could come to an agreement on an affiliation. He felt that the ASA would be more bound to such an agreement than it would to one with Carver as an individual. See [HP11].

status of an autonomous society with a fairly loose bond of affiliation'' [HP10]. Allen T. Craig, then secretary-treasurer of the IMS, confirmed Stephan's assessment a few weeks later, asserting that ''when we give weight to the consideration that one of the purposes of organizing the Institute was to help support the Annals, it does not seem reasonable that the Institute should become a section of the Association without some arrangement for the Annals to become an association publication'' [AASA16].

The attempts to maintain mathematical statistics as a branch of the more general statistical discipline ended here. When Stephan wrote to discuss the *Annals* with Carver in April, his inquiry included no mention of the publication's potential affiliation with the ASA, but rather sought to establish ''a more definite division of labor between the Annals and the Journal [of the ASA]'' [AASA17]. The division became more formal in 1938 when the IMS assumed complete financial responsibility for the *Annals* [6, 582]. Carver's successful campaign to keep the *Annals* independent of the ASA, and the strength of the IMS that permitted it to take over the publication suggest that by this time, mathematical statistics existed as an independent discipline, and its practitioners had formed a professional community. In the coming years, events external to the community, in particular America's involvement in World War II, would play a part in further defining the community's purpose and its status.

THE IMPACT OF WWII

In January, 1933, Hitler became Chancellor of Germany by presidential appointment. Under the Nazi regime, education became a weapon for ''the fanning of German nationalism and the racial mystique of Aryanism'' [81, 395]. During the next five years, almost three thousand professors and instructors lost their positions in European institutions [81, 395]. Many of these, including a significant number of scientists, fled abroad, some finding their way to the United States.

Would-be immigrants faced obstacles to their entrance to the United States in the form of the National Origin Act, passed in 1929, which limited total yearly immigration to 150,000. However, the same law provided a special dispensation for intellectuals. A clause of the act permitted the granting of non-quota visas to teachers of higher education who could demonstrate that they had a job awaiting them in the United States [24, 24–27].[18] To assist these political refugees, American individuals and institutions began to mobilize efforts to facilitate their immigration.

Private foundations such as the Carnegie Corporation and the Rockefeller Foundation assisted in the placement of refugee scholars by providing grants and fellowships to pay a scholar's salary at a college or university. In 1933, the Emergency Committee for Displaced German Scholars (later Displaced Foreign Scholars) was formed as a source of information on foreign scholars and on positions available

[18] The act limited the number of immigrants from each country to 2% of those born in that country counted in the 1890 census. It had an effect of reducing the number of immigrants from over one million from 1926 to 1930 to just under a quarter of a million from 1930 to 1935.

in the United States [13, 303–304].[19] Institutions such as the New School of Social Research emerged with the explicit goal of creating ''an atmosphere in which the displaced scholars would be able to keep alive the traditions and methods that had been the glory of their universities'' [13, 303].[20] Others, such as the Institute for Advanced Study and Brown University's department of mathematics, had leaders who used their influence to provide positions for the émigrés.

Several scientists and mathematicians played active roles in organizations assisting refugee scholars. Max Mason, who had received his Ph.D. under David Hilbert at the University of Göttingen, held the presidency of the Rockefeller Foundation. Oswald Veblen, then professor of mathematics at the Institute for Advanced Study, became a member of the Emergency Committee on its founding. R. G. D. Richardson, secretary of the American Mathematical Society from 1921 to 1940 and chair of Brown University's department of mathematics, encouraged his university to participate in assisting émigrés by hiring several mathematicians.

Partly as a result of this influence, a significant number of European mathematicians received help from the United States. The Rockefeller Foundation supported 20, and the Emergency Committee aided 26 scholars in mathematics, more than in any other scientific field. By the end of the war, more than 120 mathematicians had immigrated to the United States, many to remain permanently [58, 15]. A number of social scientists and mathematicians who would make important contributions to statistical work, and thus strengthen the ranks of the mathematical statistics community, also came in this wave of migration. In 1938 the University of California hired the Polish mathematician, Jerzy Neyman, then at University College, London. At Berkeley, Neyman started what would become an important center for mathematical statistics.[21] The Yugoslavian-born William Feller, who later wrote an influential textbook in probability [23], went to Brown in 1939 and became part of the editorial board for the newly founded *Mathematical Reviews.* Mark Kac, another Polish mathematician, joined the faculty at Cornell in 1939 [34], and Abraham Wald, dismissed from his position at the Austrian Institute for Business Cycle Research because he was Jewish, took a position at Columbia University that same year.

Although the American mathematical community would eventually recognize the importance of many émigrés' contributions to its discipline, mathematicians initially offered some resistance to including them in their ranks. The cuts in pay and losses of jobs that American scholars had experienced since the onset of the Depression, as well as the nature of the posts created for the émigrés, who usually received research rather than teaching positions, frequently resulted in their becoming ''targets for those viewing research as a luxury expendable in a time of economic crisis'' [58, 319].[22]

[19] By 1945, both the Rockefeller Foundation and the Emergency Committee had each spent over one million dollars in grants and fellowships for immigrant scholars.

[20] This school was an institution of higher adult education.

[21] For a biographical account of Neyman's life, see [57].

[22] See [58] for a detailed account of this tension.

One curb on these hostilities came from a growing interest in the application of mathematics to the war effort. When the United States entered the war in December of 1941, American scientists and mathematicians were more fully aware of the role they could play in the military effort than they had been in the First World War. During the earlier conflict, organizational structures linking scientists with research needs in the military and in industry had not begun to function effectively until just before the Armistice.[23]

By 1940, Vannevar Bush, president of the Carnegie Institution of Washington, had succeeded in obtaining an executive order from President Roosevelt establishing the National Defense Research Committee (NDRC). The order charged the committee to "correlate and support scientific research on the mechanisms and devices of warfare" [48]. The work accomplished by these newly mobilized scientists succeeded in elevating the status of applied mathematics, and consequently the status of mathematical statistics. At the same time, its contributions to the war showed that mathematical statistics still had an ambiguous place in the scientific community.

Mathematical statisticians played two central roles in the defense work of World War II. They trained industrial workers in methods of statistical quality control, and they developed and implemented means of making the equipment used in the war more effective. The War Production Board's Office of Production Research and Development (OPRD) eventually coordinated the first role, joining the Carnegie Institute of Technology, which began to offer courses in 1941. In the spring of 1942, W. Edwards Deming, then a mathematician at the Bureau of the Census and serving as an adviser to the Chief of Ordnance [82, 3], recommended that Stanford University's Committee on Instruction in Statistics offer short, intensive courses to familiarize industry executives and managers with the potential uses and the basic methods of statistical quality control in manufacturing. In addition to Deming, Samuel S. Wilks, a mathematical statistician at Princeton University, and Walter A. Shewhart, a statistician with Bell Telephone Laboratories, assisted in designing the courses. Eugene L. Grant of Stanford's engineering school and Holbrook Working, a statistician and economist at the Food Research Institute of Stanford [70, 321], served as other instructors in the program [30, 140]. Both the Carnegie Institute and Stanford University received funds for their programs from the Engineering, Science and Management War Training Program, a division of the U.S. Office of Education [83, 430]. By 1943, the OPRD had established a program to encourage and assist them as well [83, 432]. Thus, an increasing interdependence among mathematical statisticians, industry, and the federal government began to form as a result of the United States' involvement in the war.

The second role played by statisticians in the war, that of improving the effectiveness of defense equipment and methods, came for the most part under the direction of the NDRC. When first established, the NDRC had no division for research in mathematics. Many mathematicians had jobs in divisions such as the Fire Control Section and the explosives division [56, 609]. In 1942, Bush reorganized the NDRC

[23] For a discussion of the work of scientists during World War I, see [20].

and created a new group, the Applied Mathematics Panel (AMP), under the direction of Warren Weaver, who had headed the Fire Control Section [56, 609].[24] Weaver distributed work assigned to the panel to mathematicians around the country, but concentrated much of it in three groups at Columbia University: the Applied Mathematics Group, the Statistical Research Group, and the Bombing Research Group [49, 289].

Statistical work in all the groups focused on studies of damage to aircraft from anti-aircraft guns, on methods of most effectively bombing targets, and on statistical methods in production [56, 613]. These efforts provided opportunities for significant theoretical developments and "proved formative in the early careers of men who went on to become powerful figures in the statistical and economic fields" [49, 290].[25]

In particular, the statistical method of inspection now known as sequential sampling had its origins in the Statistical Research Group (SRG). This method, which has become an important part of statistical testing, involves using data as they are gathered to determine when to stop an experiment. Until its development during World War II, experiments typically consisted of a predetermined, fixed number of observations. In sequential sampling, the number of observations depends on the outcome of each. A sampling plan provides a rule for deciding, after each trial, whether to take a certain action or to make another observation.[26]

The method had emerged as a result of a Navy captain's request for a "mechanical rule which could be specified in advance stating the conditions under which the [testing] might be terminated earlier than planned." [27] W. Allen Wallis, the SRG's research director, worked on the problem with Milton Friedman before passing it on to Abraham Wald, who developed the sequential probability ratio test, a test which "frequently result[ed] in a saving of about fifty percent in the number of observations" [69, 119] needed in the traditional method of using a predetermined sample size.

The appearance of Milton Friedman's name and of the names of others involved in the Statistical Research Group suggest that at this point in the history of the statistical community, its boundaries remained blurred. Significant contributions to statistical research and implementation came from scientists whom some would have considered outsiders. In contrast, some statisticians such as Jerzy Neyman preferred theoretical studies to the "computational chores assigned him by the" AMP [49, 292], and so took smaller roles in the work of the NDRC.

The success during the war of such teams as the Statistical Research Group

[24] Weaver had been a professor of mathematics at the University of Wisconsin until 1932, when he became the director of the Rockefeller Foundation's Natural Sciences division. See [2; 39].

[25] According to W. Allen Wallis, Director of Research for the Statistical Research Group at Columbia, eight SRG members served as president of the Institute of Mathematical Statistics; four as president of the American Statistical Association; one became president of the AAAS; one received a Nobel Prize; and nine served as chairs of university departments of statistics. See [70, 324].

[26] For the details of the mathematics, see [68; 69].

[27] Wallis to Warren Weaver, March, 1950, in [70, 325]. This article contains an account of the origins of sequential sampling.

showed that what the mathematical statisticians had accomplished relative to professionalization had not prevented them from cooperating with the broader scientific community. Mathematical statistics had met some of the needs of defense and of industrial production, while those needs had created opportunities for theoretical advances.

CONCLUSION

When Lemuel Shattuck and his colleagues organized the ASA in 1839, statistics were nothing more than numerical facts about society, interesting and useful only for the information they conveyed about the population's health, wealth and tendencies toward various virtues and vices. The social scientists who began contributing to the Association's growing strength in the last decade of the 19th century maintained this view as they contributed the statistical aspects of their research to the ASA's now regular and widely disseminated publications.

As mathematicians worked their way into the organization, they began to promote more theoretical studies of the analysis of numerical data. The spokesmen for this faction, Henry Rietz and Harry Carver among them, began to discover that their increasingly technical interests appealed to a relatively narrow constituency within the ASA, and required more direct institutional support than the Association seemed willing to offer. Seeking to provide that support, Carver founded the *Annals of Mathematical Statistics* in 1929, first with the ASA's backing, later depending on his own resources. The IMS organized in 1935 to provide a firmer financial foundation for the *Annals* and to maintain high standards of research in the discipline. Their founders succeeded in setting off the inquiry into theoretical statistics as a legitimate field of study in need of its own professional accoutrements. These institutions established a border between those who sought to advance knowledge in the theory of statistics and social scientists who employed numerical facts in their own research.

In the 1940s, mathematical statisticians took part in developing more effective methods of quality control and more efficient weapons of war. Their contributions to the efforts of World War II increased interest in and respect for mathematical statistics. At the same time, they suggested that the boundary drawn in the 1930s was not impenetrable. Statisticians lent their knowledge to fields of application, while outsiders to the community contributed to important theoretical advances.

The mathematical statisticians themselves seemed to recognize their border's permeability and to see it as allowing for the further development of their discipline. The end of the war found them continuing to seek opportunities for interaction with researchers from other fields. In its 1945 report, the IMS's Committee on Postwar Development focused on ''determining how the Institute [could] cooperate more effectively with the users of statistical techniques'' [8, 109]. That same year, Jerzy Neyman organized the Berkeley Symposium on Mathematical Statistics and Probability with the purpose of ''mark[ing] the end of the war and . . . stimulat[ing] the return to *theoretical* research'' [45, v; emphasis added]. In the Foreword to the *Proceedings* of that meeting, Neyman characterized applications as ''a source of

inspiration in . . . theoretical work'' [45, v], and expressed hope that the research presented would ''foster cooperation between the experimenter and the statistician'' [45, v].

These statements by Neyman and the IMS reflected the willingness of mathematical statisticians to collaborate with the ''users of statistical technique.'' At the same time, they called attention to the independent status of the new intellectual domain. The mathematical statisticians had succeeded in serving other disciplines while advancing their own professional interests. Having defined a niche for themselves, they now had a place from which to continue promoting and strengthening their community.

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REFERENCES

Archival Sources

AASA Archives of the American Statistical Association, Special Collections Department, University Library, Iowa State University, Ames, Iowa.
AASA1 Constitution of the Institute of Mathematical Statistics
AASA2 Willford I. King to ''Annals Subscriber,'' December 8, 1933.
AASA3 Willford I. King to ''Fellow Member,'' December 8, 1933.
AASA4 Willford I. King and Frank A. Ross, ''Special Committee on the Finances of the *Annals of Mathematical Statistics,*'' December 26, 1933.
AASA5 Secretary's Assistant of the ASA to Harry C. Carver, January 10, 1934.
AASA6 Harry C. Carver to Frederick C. Mills, October 22, 1934.
AASA7 Frederick C. Mills to Harry C. Carver, December 3, 1934.
AASA8 Paul R. Rider to selected recipients, January 8, 1935.
AASA9 Abstracts of responses to Paul R. Rider's letter, March 14, 1935.
AASA10 Frederick Stephan to Walter A. Shewhart, March 27, 1935.
AASA11 ''Proposed Plan for the *Annals of Mathematical Statistics,*'' May 7, 1935.
AASA12 Henry L. Rietz to Frederick Stephan, May 13, 1935.
AASA13 ''Suggested Plan for the Affiliation of the Proposed Institute of Mathematical Statistics with the American Statistical Association,'' May 17, 1935.
AASA14 Frederick Stephan to Harry C. Carver, May 23, 1935.
AASA15 Allen T. Craig to Frederick Stephan, September 21, 1935.
AASA16 Allen T. Craig to Frederick Stephan, January 7, 1936.
AASA17 Frederick Stephan to Harry C. Carver, April 22, 1936.
HP Personal files of Robert V. Hogg, Division of Mathematical Sciences, University of Iowa, Iowa City, Iowa.
HP1 Allen T. Craig to selected recipients, July 15, 1935.
HP2 A. L. O'Toole, W. A. Shewhart, and Paul R. Rider [The Committee on Constitution and By-Laws of the Institute of Mathematical Statistics] to Henry L. Rietz, July 30, 1935.
HP3 Henry L. Rietz to A. L. O'Toole, August 9, 1935.
HP4 A. L. O'Toole to Henry L. Rietz, August 12, 1935.

HP5 Frederick C. Mills to Henry L. Rietz, August 26, 1935.
HP6 Harry C. Carver to L. L. Thurstone, November 1, 1935.
HP7 Frederick Stephan to Harry C. Carver, December 13, 1935.
HP8 Harry C. Carver to Henry L. Rietz, December 16, 1935.
HP9 Harry C. Carver to Frederick Stephan, December 17, 1935.
HP10 Frederick Stephan to Henry L. Rietz, December 23, 1935.
HP11 Harry C. Carver to Henry L. Rietz, February 12, 1936.

Published Sources

1. Active Committees, *Journal of the American Statistical Association* **19** (1924), 240.
2. *American Men of Science,* 6th ed., s.v. ''Weaver, Warren.''
3. *American Men of Science,* 7th ed., s.v. ''Carver, Harry C.''
4. *American Men of Science*, 7th ed., s.v. ''King, Willford I.''
5. *American Men of Science,* 7th ed., s.v. ''Wilson, Edwin B.''
6. The *Annals of Mathematical Statistics*, *Journal of the American Statistical Association* **33** (1938), 582–583.
7. Donald R. Belcher, What is Expected of Statisticians by Employers in the Field of Business, *Journal of the American Statistical Association* **21** (1926), 424–430.
8. C. I. Bliss, W. E. Deming, P. S. Olmstead, and S. S. Wilks, Progress Report of the Committee on Post-war Development of the Institute, *Annals of Mathematical Statistics* **16** (1945), 109–111.
9. Robert V. Bruce, *The Launching of Modern American Science*, Ithaca: Cornell Univ. Press, 1987.
10. Patricia Cline Cohen, *A Calculating People: The Spread of Numeracy in Early America*, Chicago: Univ. of Chicago Press, 1982.
11. Cecil C. Craig, Early Days in Statistics at Michigan, *Statistical Science* **1** (1986), 292–293.
12. Cecil C. Craig, Harry C. Carver, 1890–1977, *The Annals of Statistics* **6** (1978), 1–4.
13. Maurice R. Davie, *Refugees in America: Report of the Committee for the Study of Recent Immigration from Europe*, New York: Harper, 1947.
14. Davis R. Dewey, Study of Statistics, *Publications of the American Economic Association* **4** (1889), 359–376.
15. Davis R. Dewey, The Halfway Point, *Journal of the American Statistical Association* **35** (1940), 236–240.
16. *Dictionary of American Biography,* 1931 ed., s.v. ''Gould, Elgin R. L.,'' by Helen Sumner Woodbury.
17. *Dictionary of American Biography,* 1936 ed., s.v. ''Jarvis, Edward,'' by William R. Leonard.
18. *Dictionary of American Biography,* 1936 ed., s.v. ''Warner, Amos G.,'' by Mary Roberts Coolidge.
19. *Dictionary of American Biography*, 1936 ed., s.v. ''Wright, Carroll D.,'' by Broadus Mitchell.
20. A. Hunter Dupree, *Science in the Federal Government: A History of Policies and Activities,* Cambridge, MA: Harvard Univ. Press, Belknap Press, 1957; reprint ed., Baltimore: Johns Hopkins Univ. Press, 1986.
21. *Encyclopedia of Statistical Sciences*, 1983 ed., s.v. ''Institute of Mathematical Statistics,'' by Paul S. Dwyer.
22. Roland P. Falkner, Prison Statistics of the United States for 1888, *Publications of the American Statistical Association* **1** (1889), 299–327.
23. William Feller, *An Introduction to Probability Theory and Its Applications*, New York: Wiley, 1950.
24. Laura Fermi, *Illustrious Immigrants,* 2d ed., Chicago: Univ. of Chicago Press, 1971.
25. Roger L. Geiger, *To Advance Knowledge: The Growth of American Research Universities, 1900–1940,* New York: Oxford Univ. Press, 1986.
26. James W. Glover, Work of the Association's Committee on Professional and Educational Standards for Statisticians, *Journal of the American Statistical Association* **19** (1924), 399–400.

27. James W. Glover, Statistical Teaching in American Colleges and Universities, *Journal of the American Statistical Association* **21** (1926), 419–424.
28. E. R. L. Gould, Park Areas and Open Spaces in American and European Cities, *Publications of the American Statistical Association* **1** (1888), 50–61.
29. Gerald Grob, *Edward Jarvis and the Medical World of Nineteenth-Century America,* Knoxville: Univ. of Tennessee Press, 1978.
30. Boyd Harshbarger, Modern Statistics in America (1920–1944), in *On the History of Statistics and Probability,* ed. D. B. Owen, New York: Dekker, 1976, pp. 131–145.
31. John Higham, The Matrix of Specialization, in *The Organization of Knowledge in Modern America, 1860–1920,* ed. Alexandra Oleson and John Voss, Baltimore: Johns Hopkins Univ. Press, 1970, pp. 3–18.
32. Robert V. Hogg, On the Origins of the Institute of Mathematical Statistics, *Statistical Science* **1** (1986), 285–291.
33. Edward Jarvis, Births, Marriages, and Deaths in Massachusetts, *American Journal of the Medical Sciences* **24** (July 1852), 147–164.
34. Mark Kac, *Enigmas of Chance: An Autobiography,* New York: Harper & Row, 1985.
35. Joseph C. G. Kennedy, *The Progress of Statistics, Read Before the American Geographical Society, at the Annual Meeting in New York, December 1, 1859,* New York: J. F. Trow, 1861.
36. Daniel Kevles, *The Physicists: The History of a Scientific Community in Modern America,* New York: Knopf, 1978.
37. Daniel Kevles, The Physics, Mathematics, and Chemistry Communities: A Comparative Analysis, in *The Organization of Knowledge in Modern America, 1860–1920,* ed. Alexandra Oleson and John Voss, Baltimore: Johns Hopkins Univ. Press, 1970, pp. 139–172.
38. Willford I. King, Content and Purpose of Training in Elementary and Advanced Statistics, *Journal of the American Statistical Association* **21** (1926), 430–435.
39. Robert E. Kohler, Warren Weaver and the Rockefeller Foundation Program in Molecular Biology: A Case Study in the Management of Science, in *The Sciences in the American Context: New Perspectives,* ed. Nathan Reingold, Washington, DC: Smithsonian Institution Press, 1979, pp. 249–293.
40. Mansfield Merriman, *A Text-Book on the Method of Least Squares,* 8th ed., New York: Wiley, 1907.
41. Mansfield Merriman, *Elements of the Method of Least Squares,* London: Macmillan and Co., 1877.
42. Miscellaneous Notes, *Journal of the American Statistical Association* **19** (1924), 97–99.
43. Simon Newcomb, Notes on Probability, *The Mathematical Monthly* **3** (1860–1861), 119–125.
44. Simon Newcomb, Note on the Frequency of Use of the Different Digits in Natural Numbers, *American Journal of Mathematics* **4** (1881), 39–40.
45. Jerzy Neyman, ed., *Proceedings of the Berkeley Symposium on Mathematical Statistics and Probability,* Berkeley: Univ. of California Press, 1949.
46. Jerzy Neyman, The Emergence of Mathematical Statistics, in *On the History of Statistics and Probability,* ed. D. B. Owen, New York: Dekker, 1976, pp. 147–193.
47. Notice of the Organization of the Institute of Mathematical Statistics, *Annals of Mathematical Statistics* **6** (1935), 227.
48. Order Establishing the National Defense Research Committee, in *Scientists Against Time,* ed. James Phinney Baxter, Boston: Little, Brown, 1946, p. 451.
49. Larry Owens, Mathematicians at War: Warren Weaver and the Applied Mathematics Panel, 1942–1945, in *The History of Modern Mathematics,* ed. David E. Rowe and John McCleary, 2 vols., Boston: Academic Press, 1989, **2:**287–305.
50. William Riley Parker, The MLA, 1885–1953, *Proceedings of the Modern Language Association* **68**, pt. 2 (1953), 3–39.
51. Karen H. Parshall and David E. Rowe, *The Emergence of the American Mathematical Research*

Community 1876–1900: J. J. Sylvester, Felix Klein, and E. H. Moore, Providence: Amer. Math. Soc./ London: London Math. Society, 1994.

52. Benjamin Peirce, Criterion for the Rejection of Doubtful Observations, *Astronomical Journal* **2** (1852), 161–163.
53. Charles Sanders Peirce, On the Coincidence of the Geographical Distribution of Rainfall and of Illiteracy, as Shown by the Statistical Maps of the Ninth Census Reports (Abstract), *Bulletin of the Philosophical Society of Washington* **1** (1872), 68.
54. Charles Sanders Peirce, On the Theory of Errors of Observations, appendix no. 21, *Report of the Superintendent of the U.S. Coast Survey for the Year Ending June 1876,* Washington: Government Printing Office, 1873, pp. 200–224 and plate 27, or *The New Elements of Mathematics,* ed. Carolyn Eisele, 3 vols., Atlantic Highlands, NJ: Humanities Press, 1976, 3:639–676.
55. Theodore M. Porter, *The Rise of Statistical Thinking: 1820–1900,* Princeton, NJ: Princeton Univ. Press, 1986.
56. Mina Rees, The Mathematical Sciences and World War II, *The American Mathematical Monthly* **87** (1980), 607–621.
57. Constance Reid, *Neyman: From Life,* New York: Springer-Verlag, 1982.
58. Nathan Reingold, Refugee Mathematicians in the United States of America, 1933–1941: Reception and Reaction, *Annals of Science* **38** (1981), 313–338, or *A Century of Mathematics in America—Part I,* ed. Peter Duren *et al.,* Providence: Amer. Math. Soc., 1988, pp. 175–200.
59. Stuart A. Rice and Morris Green, Composition of the American Statistical Association, *Journal of the American Statistical Association* **25** (1930), 198–202.
60. Henry L. Rietz and Arthur R. Crathorne, Mathematical Background for the Study of Statistics, *Journal of the American Statistical Association* **21** (1926), 435–440.
61. Henry L. Rietz, *Mathematical Statistics,* Chicago: Math. Assoc. of Amer., 1927.
62. Margaret W. Rossiter, *Women Scientists in America: Struggles and Strategies to 1940,* Baltimore: Johns Hopkins Univ. Press, 1982.
63. Edwin R. A. Seligman, Finance Statistics of the American Commonwealths, *Publications of the American Statistical Association* **1** (1889), 349–368.
64. Stephen M. Stigler, Mathematical Statistics in the Early States, *The Annals of Statistics* **6** (1978), 239–265.
65. Stephen M. Stigler, *The History of Statistics: The Measurement of Uncertainty before 1900,* Cambridge, MA: Harvard Univ. Press, Belknap Press, 1986.
66. Stephen M. Stigler, A Look Backward on the Occasion of the Centenary of JASA, *Journal of the American Statistical Association* **83** (1988), 583–587.
67. Laurence R. Veysey, The Plural Organized Worlds of the Humanities, in *The Organization of Knowledge in Modern America, 1860–1920,* ed. Alexandra Oleson and John Voss, Baltimore: Johns Hopkins Univ. Press, 1970, pp. 51–106.
68. Abraham Wald, Sequential Method of Sampling for Deciding Between Two Courses of Action, *Journal of the American Statistical Association* **40** (1945), 117–186.
69. Abraham Wald, Sequential Tests of Statistical Hypotheses, *Annals of Mathematical Statistics* **16** (1945), 277–306.
70. W. Allen Wallis, The Statistical Research Group, 1942–1945, *Journal of the American Statistical Association* **75** (1980), 320–335.
71. Amos G. Warner, Notes on the Statistical Determination of the Causes of Poverty, *Publications of the American Statistical Association* **1** (1889), 183–201.
72. *Who's Who in America,* 1946 ed., s.v. ''Belcher, Donald R.''
73. *Who's Who in America,* 1946 ed., s.v. ''Camp, Burton Howard.''
74. *Who's Who in America,* 1946 ed., s.v. ''Hotelling, Harold.''

75. *Who's Who in America,* 1946 ed., s.v. ''Mills, Frederick Cecil.''
76. *Who's Who in America,* 1950 ed., s.v. ''Crathorne, Arthur R.''
77. *Who's Who in America,* 1950 ed., s.v. ''Stephan, Frederick Franklin.''
78. *Who Was Who in America,* 1942 ed., s.v. ''Glover, James W.''
79. Walter F. Willcox, Lemuel Shattuck, Statist, Founder of the American Statistical Association, *Journal of the American Statistical Association* **35** (1940), 224–235.
80. Edwin B. Wilson, Mathematics and Statistics, *Journal of the American Statistical Association* **25** (1930), 1–8.
81. Anthony Wood, *Europe: 1815–1969,* Harlow, England: Longman, 1984.
82. Holbrook Working, Making Statistical Methods Contribute to the War Effort, *American Statistical Association Bulletin* **3** (1943), 2–4.
83. Holbrook Working, Statistical Quality Control in War Productions, *Journal of the American Statistical Association* **40** (1945), 425–447.
84. Carroll D. Wright, Statistics in Colleges, *Publications of the American Economic Association* **3** (1888), 5–28.